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Commentary

Overview of Agricultural Dust Research: Agricultural Research Service Perspective

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Dusts generated by farm products are becoming increasingly recognized as causing adverse health effects, particularly in those persons chronically exposed to amounts having recognized biological effects.

The Agricultural Research Service (ARS) is always concerned when a problem affects agricultural production and use of the product. We also recognize that the technical data base for the effects of agricultural dusts and its relationship to traditional industrial or occupational health information is unquestionably still in an embryonic state. In this respect, we particularly appreciate the opportunity to share our knowledge and research results with all of the other institutions represented here. When the research requires specialized expertise, cooperative programs are often the most expeditious way to solve a problem.

We are proud of the efforts that have been put forth in response to the needs of the cotton industry to provide a safer workplace. Programs to handle and decrease dust in cotton gins and mills have been in place in ARS laboratories for a number of years. The effort was increased in 1977, when Ralph McCracken, then Associate Administrator of ARS, sought the cooperation of NIOSH in a study to evaluate closed boll harvesting as a means to reduce generation of respirable dust during subsequent processing. There was no adverse respiratory response to closed boll cotton; however, extensive changes in harvesting, handling, and processing would have been necessary to produce such cottons. At that time or even at the present, these alterations would only constitute a long-term solution requiring many capital intensive changes. Thus, other solutions needed to be explored. In 1980, a cotton industry task force called upon USDA for an intensified effort to solve the byssinosis problem. The industry, working with the Secretary of Agriculture and the Congress, was able to get an additional $975,000 appropriation for ARS to devote to this effort. Congress mandated that release of these new funds was contingent on the agreement that all parties pursue "a cooperative research program designed to identify and eliminate the causative factors responsible for the worker health hazard caused by long exposure to dust generated during processing of cotton flax and hemp." These cooperating groups include the National Institute of Occupational Safety and Health (NIOSH), Cotton Incorporated (CI), the National Cotton Council and the Cotton Foundation (Foundation), the American Textile Manufacturers Institute (ATMI), and the Amalgamated Clothing and Textile Workers Union (ACTWU). A memorandum of understanding outlined the responsibilities of each of the participating groups.

This agreement has been a model of cooperative efforts between Government, industry, and union representatives. A steering group, originally called the Task Force on Washed Cotton Evaluation, has helped guide the general direction of the research of each of the member groups. "Washed cotton" was emphasized in the name because washing was the principal strategy envisioned at the beginning to try to rid cotton of the factors causing byssinosis. The OSHA Cotton Dust Standard exempted the handling or processing of "washed cotton" from regulation. The work of the cooperating groups has evolved since that time to focus on the etiology of the condition. Members of the Task Force believe that in order to provide the manufacturer with a risk-free bale of cotton, the causative agent(s) must be first identified. We will then be able to develop methods to either remove, deactivate, and/or prevent the occurrence of the agents in cotton dust that cause adverse respiratory health responses in workers.

The work carried out by the cooperating groups has centered around exposure of human volunteers to minute amounts of dust at the ARS Cotton Quality Laboratory at Clemson, South Carolina. The medical aspects of these studies have been carried out by NIOSH, and much of the experimental cotton has been supplied by Cotton Inc. These studies were pioneering in their identification of quantitatively different responses from cottons washed with varying temperatures and treatments, such as bleaches and scouring agents, and from cottons grown in different areas. Again, just as with

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"green boll" cotton, washed cotton could not be a viable alternative to engineering controls for cotton dust without a commercially acceptable washing method.

Recently, work with a highly promising animal model for byssinosis has begun. Scientists at the University of Pittsburgh have shown that guinea pigs will develop the typical Monday morning illness of the cotton mill worker. As exposure of the animals is continued, their respiratory distress becomes greater just as with human workers. With increasingly stringent requirements regarding the use of humans as research subjects, the development and validation of this guinea pig model is essential. For instance, we hope to use guinea pigs to be able to evaluate cottons treated with inactivating agents, work that could not be carried out at least initially with human subjects.

Last year's annual report from ARS on byssinosis included work from six different locations. Here at New Orleans and in Beltsville we supported the studies with human volunteers with research to determine the exact composition of the cotton used. These elemental and proximal chemical analyses as well as the characterization of the bacterial flora will help us set a standard for washed cotton. In other studies we are developing procedures for quantitating fatty acids hydrolyzed from bacterial lipopolysaccharides. D-Glycero-L-mannoheptase has been synthesized from D-galactose up to the final crystallization step. This enantiomer is indistinguishable from the natural heptose by chromatographic and spectrometric methods and will serve as a standard for the development of GC and GC/MS methods to analyze for bacterial endotoxins. Also, a Beltsville scientist hopes to find a common antigen among the various gram negative bacteria in large numbers found on cotton at harvest. This would allow us to explore the differences and similarities in this important group of bacteria.

Another agricultural dust with possible health implications is that from grain. ARS programs with the health aspects of grain dust have centered in two areas: (1) that of on the farm and local elevator sampling and (2) that work carried out in New Orleans in cooperation with Tulane University on the fungal and mycotoxin content of grain dust in terminal elevators. In the New Orleans elevators, fungi of the Aspergillus, Penicillium, and Fusarium species were found, all of which are common flora in grain. All are capable of producing mycotoxins, however, relatively small amounts were found even in the settled dusts. As might be expected, much higher amounts were found in the fields from a farm where mycotoxins had been recognized as a problem. Lesser amounts were found associated with corn at a local elevator. Dust from these latter locations was collected with personal samples.

Only limited inhalation studies have been carried out to evaluate the significance of aflatoxin in respirable dust. At the National Animal Disease Center, an extremely low dose, 0.006 mg/kg, administered to rats by absorption onto dead spores of *Aspergillus fumigatus* apparently affected the immune system since chronic murine pneumonia was increased in the treated animals.

Just as in other programs, ARS research on the effects of respirable agricultural dusts focuses on specific problem areas. We are particularly concerned that we use our limited resources to seek solutions to specific problems and not to merely further define the problem.

For instance, in our byssinosis research at the Clemson Cotton Quality Laboratory, we started evaluating a solution, that is, the washing of cotton. We found that washing did decrease the response of the volunteers to cotton dust, but it also resulted in a cotton that was not spinnable without additives to replace some of the natural waxes. Also, the washing process itself, and particularly the subsequent drying, is energy-intensive. Thus, other solutions must be examined. In order to do this, we must have an agreement regarding the causative agent. This will enable us to devise very specific solutions, that is, products or processes that affect only this causative agent. Those which may also affect the useful properties of cotton fiber are just not acceptable.

I believe the work with endotoxin is very promising. We already know that endotoxin is present in large amounts in cotton dust, and that medical research has found that it is specifically toxic to at least the lung and the liver, as well as being a pyrogen. The significance of the endotoxin research goes beyond that of the cotton dust problem, since it has been found in significant quantities in nontextile industry locations, including grain elevators, chicken slaughterhouses, and even office buildings. Cotton bract also contains phenols and tannins and other compounds that are physiologically active in *in vitro* studies. The important question to determine is whether these chemicals are sufficiently active in the amounts generally inhaled to account for the symptoms and lesions noted in both the human volunteers and the workers.

It is here again that the animal model is essential to help make this differentiation between possible etiologies. It is too easy with *in vitro* assays to regard positive results to be of clinical significance, while in fact they indicate only the potential for biological activity. The whole animal is a filter mechanism to help us screen out those substances not accessible to the target cells in sufficient amounts to produce toxicity. With the animal model as opposed to the limited exposure ethically possible with human volunteers, we can administer doses sufficiently high to yield reproducible results. Because the pattern of acute response observed thus far in guinea pigs is similar to that in humans, we can make the assumption that the results have significance for human exposure. The foundation of this extrapolation needs to be more rigorously examined, and studies will be carried out in the coming year.

The ARS has a continuing commitment to assuring the safety of agricultural production. This includes not only the safety of food or fiber itself, but also the safety questions that arise in the production of this food. When a recognized question of safety arises, we will respond within the limits of our resources and scientific expertise to try to develop a practicable solution.